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Growth Constraints and Determinants of a South Pacific Island in a Global Economy: A Study of Fiji

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ABSTRACT *In a global economy, the South Pacific islands face unique constraints to growth. The study investigates whether Fiji was benefited by three-decade old open trade policies. Through a multivariate cointegration analysis, the study establishes the existence of a long-run relationship between open trade policy and physical and human capital resources. Although physical capital had a positive impact on growth, the existing complementary relationship between two kinds of capital requires that a threshold between physical and human capital needs to be attained before any negative influence on growth can be transformed into positive impact.*

KEY WORDS: open trade policy, endogenous growth, physical capital, human capital, cointegration

Introduction

Recent studies on fast growing small countries, especially the island nations in the Indian Ocean and the Caribbean regions, which have limited natural resources in terms of arable land and minerals, have kindled interest in the application of endogenous growth theory in contrast to previous studies. Some past studies, including those by Bauer (1991) and Bertram (1993), argued that growth rates were mainly driven by external factors such as official development aid (ODA) and therefore, well-explained by exogenous growth theory. Romer (1993) concluded that the success story of Mauritius, which reduced its export dependency on traditional sugar by fostering exports of garments could be best explained in terms of "old" or exogenous growth theory rather than "new" or endogenous theory. This is so, despite the fact that transfer of skills and acquisition of knowledge from overseas investors from Hong Kong, who were attracted to Mauritius by aggressive investor friendly policies, were important factors in driving the initial development of the garment industry.

However, Ghatak and Milner (2004) argued that externality effects of productivity growth had to be recognized. They emphasized that the externalities conferred

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greater opportunities for outward oriented trade policy inducing dynamic benefits. Recognizing the difficulty in distinguishing in the empirical modelling between technology or productivity effects, as represented by traditional growth models, and those effects that the new growth models are seeking to capture, the two authors in their study on Mauritius devised an estimable form of an endogenous growth model. With a trade-augmented old model, they included human capital accumulation, in addition to the traditional explanatory factors of capital and labour. Through a multivariate cointegration analysis, it was observed that a long-run relationship existed, running from human capital and trade policy to growth (Ghatak & Milner, 2004).

The earlier findings appear to be relevant to South Pacific island countries (SPICs) as well. Similar to Mauritius, Fiji's growth engine for the past several decades has been the sugar industry, despite the emergence of tourism in recent years. However, while Mauritius took early action to wean away from sugar exports, Fiji delayed its efforts to restructure its ailing sugar industry to reduce costs of production towards becoming globally competitive. The objective of the paper is to study determinants of growth in Fiji by applying an endogenous growth model. The remainder of the paper is organized on the following lines: the second section provides a brief background of Fiji's economy; the third section outlines the methodology adopted for the study; the fourth section reports the results; and the fifth and final section is a summary listing some conclusions with policy implications.

Fiji's Economy: A Brief Background

Fiji, a lower middle-income economy is dependent on sugar exports and tourism earnings. Compared with other SPICs, Fiji has a relatively well-developed infrastructure and is endowed with forest, mineral and fishery resources that provide support for economic development (World Bank, 2002). Further, Fiji's social development indicators have also been relatively high with human development index value of 0.763, the highest among the SPICs. Its adult literacy rate was 92.6% (United Nations Development Programme, 1999).

Since its independence in 1970 until the mid-1980s, Fiji was more inward looking with restrictive policies on trade and financial sectors. The immediate post military-coup years (1988–1992), however, witnessed a shift in economic policies. The economy was gradually liberalized and restrictions on import trade were eased along with measures for export promotion and diversification. In the process, Fiji postponed its efforts to restructure its ailing sugar industry, with the result that the sugar industry has yet to become globally competitive. However, the continuations of Lome Conventions and sugar protocols signed with the European Union (EU) have been providing not only market access but also much needed foreign exchange receipts, as Fiji's sugar exports were accorded a preferential treatment at nearly three times the world price.

Although Fiji's exports diversification efforts proved effective by developing new exporting opportunities, such as gold, spices and garments, success has however been eluding. Fiji's growth during the last 20 years has been erratic with volatile fluctuations, which were attributed to political instability. Gross domestic product (GDP) per capita grew at 0.77% per annum between 1980 and 2001 (Table 1).

Table 1. Selected macro-economic indicators and foreign financial resources in Fiji: 1980–2001

Year	Annual growth rate (%)				Foreign financial inflows (as percentage of GDP)		
	Real GDP per capita	Real investment per capita	Real education expenditure per capita	Openness ratio	Foreign aid and development assistance	Portfolio investment	Foreign direct investment
1980	−3.621	7.830	−7.867	10.901	3.002	−2.492	3.015
1981	4.355	10.843	−0.331	−0.588	3.271	−4.627	2.924
1982	−7.693	−12.149	4.295	−12.320	2.967	0.000	3.081
1983	−6.291	−14.736	3.008	−3.991	2.915	−1.266	2.840
1984	6.288	−11.524	2.247	−5.495	2.656	0.000	1.978
1985	−5.524	0.857	−11.505	−0.960	2.798	0.000	1.902
1986	5.179	−12.312	−3.675	−9.499	3.294	0.000	0.620
1987	−7.517	−0.384	−8.025	7.916	3.023	0.000	1.365
1988	1.234	−8.514	−17.862	16.384	4.899	−0.314	2.846
1989	12.450	−3.320	15.401	4.295	3.447	0.000	0.701
1990	1.207	7.794	1.220	7.597	3.654	0.000	6.655
1991	−1.500	12.257	−0.475	−14.516	3.086	0.000	0.353
1992	3.791	−15.811	3.629	−12.010	4.096	0.000	6.649
1993	1.285	29.547	7.485	1.948	3.729	0.000	5.536
1994	3.127	−12.911	−4.663	6.579	2.249	0.000	3.707
1995	3.135	6.865	−2.980	−0.386	2.253	0.000	3.491
1996	2.322	8.289	−1.567	7.847	2.224	0.000	0.114
1997	−1.773	−0.500	1.429	−6.809	2.099	0.000	0.736
1998	0.354	45.784	−6.078	−1.674	2.229	0.000	6.477
1999	8.347	2.987	5.372	5.595	1.874	0.000	−1.784
2000	−4.104	−19.299	12.186	8.821	1.768	0.000	−4.209
2001	1.951	20.302	1.930	−4.769	1.541	0.000	−0.154
Average 1980–1990	0.006	−3.238	−2.099	1.295	3.266	−0.791	2.539
Average 1991–2001	1.539	7.047	1.479	−0.852	2.468	0.000	1.901
Average 1980 –2001	0.773	1.904	−0.310	0.221	2.867	−0.395	2.220

Source: World Bank, World Development Indicator 2003 CD-ROM.

Following the introduction of trade liberalization policy, Fiji's average growth rate showed some improvement between 1991 and 2001 (1.54%).

Fiji has been seeking international capital inflows as an alternative to foreign aid. As Fiji's financial and capital markets remain to be undeveloped and private investment activities continue to be small, capital inflows have not been remarkable. Further, there are considerable institutional and structural rigidities in factor markets as well, especially in regard to customary land tenure, restricting availability of marketable land for land based investment activities (Jayaraman & Choong, 2005).

The Model

The traditional growth model, which did not incorporate policies such as export promotion and other government driven efforts, is on the lines of the well-known Solow (1956) model. Solow assumed economic growth is driven only by exogenous technical progress. The well-behaved production function is written as follows:

$$Y = f(K, L) \tag{1}$$

where K is capital, L represents the efficiency units of labour, i.e. $L = L_0 e^{(\mu+\lambda)t}$, μ is the exogenous technology-induced productivity growth rate and λ the growth rate of the population.

Equation (1), can be written as:

$$Y = LF(k) \tag{2}$$

where $k = K/L$

By transforming Equation (1) into a Cobb–Douglas production form, we obtain $Y = K^{\alpha} L^{(1\text{-}L\alpha)}$. In per capita terms, the steady growth rate of output and capital is equal to the rate of technical progress (λ).

By logarithmically differentiating Equation (1), we obtain

$$\Delta Y = \alpha \Delta K + (1 - \alpha)\Delta L \tag{3}$$

where α and (1 – α) are the factor shares of capital and labour.

For incorporating the influence of government policies aiming at export promotion and diversification efforts in the production function, Kavoussi (1984) and Feder (1983) added one more variable d, which is defined as a function of trade policy and exports growth rate. However, Ghatak and Milner (2004) observe that this *ad hoc* modification of the Solow-type growth model did not fully capture the external productivity effects on increasing returns to scale and human capital. They suggest the new endogenous growth models (Romer, 1986, 1990; Lucas, 1988) for capturing the effects of policy measures and other aspects such as openness. The production function with increasing returns to scale is re-written as follows:

$$Y = K^{\alpha} L^{\beta} H^{\gamma} \tag{4}$$

where H represents human capital.

The increasing returns to scale is represented by the sum of $(\alpha + \beta + \gamma)$ exceeding one. The "learning by doing" effects of human capital can be captured by making the marginal product of capital (α) a function of human capital as $\alpha = \mu \Delta H$.

In per capita terms,

$$\Delta y = f(k, h)$$

To this relationship, we can add a policy variable (d) representing government measures. Thus, we have an endogenous model, by including human capital in the modified Solow-type growth models of Kavoussi (1984) and Feder (1983). As policy measures take time to have effect, long-term relationships have to be studied over period. Ghatak and Milner (2004) observe endogenous models unlike exogenous models are consistent with policy innovations having both temporary and permanent effects on per capita growth rate. Thus, a time series analysis is justified for investigating both short-term dynamics and long-term equilibrium relationship between growth and policy measures.

A multivariate model of growth for Fiji is accordingly proposed on the following lines for a 34-year period (1970–2003):

$$Ly_t = \beta_0 + \beta_1 Lk_t + \beta_2 Lh_t + \beta_3 Lp_t \tag{5}$$

where y is per capita GDP in constant prices (in Fiji dollars), k per capita gross capital formation in constant prices (in Fiji dollars), h per capita government expenditures on education in constant prices (in Fiji dollars), p trade policy variable, proxied by openness (ratio of exports and imports to GDP), t, time and L, logarithm.

A dummy variable is added to the estimating procedure for capturing the likely effects of political instability introduced by two military coups of 1987 and a non-military coup in 2000. The dummy variable takes the value of zero for each year since 1970 until 1987 and value of one for all subsequent years reflecting the lingering impact of coups of 1987 until 2003.

Data and Methodology

Stationarity and Order of Integration

In order to avoid spurious regression, we need to investigate whether the data series are afflicted with unit root problems. By doing so, we ensure the validity of the usual test statistics such as t- and F-statistics, and R^2 (Granger & Newbold, 1974). Stationarity could be achieved by appropriate number of differencing, which is called order of integration. We use augmented Dickey–Fuller (ADF) (Dickey & Fuller, 1979) and Ng and Perron (2001) unit root tests to check the stationarity properties of the variables. Even though the ADF test controls for higher-order correlation by adding lagged difference terms of the dependent variable to the right-hand side of the regression, the usual Dickey–Fuller tests of the unit root null hypothesis can have little power when the root is very close to the unity circle (that is, estimated coefficient is closed to one) and decreases as deterministic factors are added (Perron, 1989). As a result, Ng and Perron (2001) modified the Phillips–Perron's (PP) Z tests and constructed a group of unit root tests (called GLS-MZ tests) with good size and power. The proposed test has a high power in the local frontier to unity in the presence of different estimates for deterministic factors and, accordingly, is highly appropriate for the purpose of the study.

Vector Autoregressive (VAR) Model and Vector Error Correction Model (VECM)

The vector autoregression (VAR) model is generally used for forecasting a system of interrelated macro-economic time series and for analysing the dynamic impact of random disturbances on the system of variables. Following Johansen and Juselius (1990) and Johansen (2000), the specification of the sampling distribution for the growth model, as stated in Equation (5) is supposed to be of four variables. Let $Z_t = (Ly_t, Lh_t, Lk_t, Lp_t)'$ and assume that this vector is generated from a VAR(k) model with a constant term and Gaussian errors $\varepsilon_t \sim niid(0, \Sigma)$.

$$Z_t = \Pi_1 Z_{t-1} + \Pi_2 Z_{t-2} + \cdots + \Pi_k Z_{t-k} + \phi + \varepsilon \tag{6}$$

Then, we re-write Equation (6) in the error correction form:

$$\begin{aligned} \Delta Z_t &= \Pi Z_{t-1} + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \cdots + \Gamma_{k-1} \Delta Z_{t-k+1} + \phi + \varepsilon_t \Pi \\ &= I\text{-}\Pi_1\text{-}\Pi_2\text{-}\cdots\text{-}\Pi_k \end{aligned} \tag{7}$$

where ΔZ_t contains the growth rates of the variables, the parameters ($\Gamma_1, \ldots, \Gamma_{k-1}$) define the short-run adjustment to the changes of the process and are estimable parameters, whereas $\Pi = \alpha\beta'$ defines the short-run adjustment (α), and the long-run relations (β). Johansen (2000) proves that if $Z_t \sim I(1)$, Π has the reduced rank of r and can be represented as $\Pi = \alpha\beta'$. The parameterization in $\Pi = \alpha\beta'$ facilitates the investigation of the r linearly independent stationary relations between the levels of the variables, and the $p - r$ linearly independent non-stationary relations. Thus, the representation of $\Pi = \alpha\beta'$ implies that the process ΔZ_t is stationary, ΔZ_{t-1} is non-stationary, but also that $\beta' Z_{t-1}$ is stationary (Johansen, 2000). We, therefore, can interpret the relation $\beta' Z_{t-1}$ as the stationary relations among non-stationary variables, that is, as cointegrating relations. Therefore, we can exploit the idea that there may appear co-movements in their behaviour and possibilities that they will move together towards a long-run equilibrium state. Johansen (1991, 2000) and Johansen and Juselius (1990, 1992) developed the likelihood procedure for estimating the parameters, and testing the order of cointegration rank and the various hypotheses on the restrictions of parameters.

If two or more variables are cointegrated, an error correction term (ECT) can be incorporated into the short-run model in estimating causality (Engle & Granger, 1987). This is because, according to the standard Granger causality tests, it is possible to find any causal relationship between two or more variables that are cointegrated (Granger, 1988). The inclusion of ECT reintroduces the information lost in the differencing process, thereby allowing for long-run equilibrium as well as short-run dynamics. On expanding out Equation (7), the model can be expressed as follows:

$$\begin{aligned} \Delta Ly_t = \beta_0 &+ \sum_{s=1}^{p} \beta_1 \Delta Ly_{t-s} + \sum_{s=1}^{p} \beta_2 \Delta Lh_{t\text{-}s} + \sum_{s=1}^{p} \beta_3 \Delta Lk_{t\text{-}s} \\ &+ \sum_{s=1}^{p} \beta_4 \Delta Lp_{t\text{-}s} + \sum_{s=1}^{p} \beta_5 \mathrm{DUM} + \delta_1 \mathrm{ECT}_{t\text{-}1} + \varepsilon_t \end{aligned} \tag{8}$$

The Equation (8) exhibits the intertemporal interaction among output, labour, capital, openness ratio included in the Fijian growth model. In the estimation of short run causality model, we follow the Hendry's (1987) general-to-specific framework. The technique departs from the general autoregressive distributed lag representation with ECT calculated from relevant estimated cointegrating vector. The terms on the right-hand side of Equation (8) represent the short- term dynamic interaction between real GDP and its determinants, and the conventional tests of causality may be based on the significance of these terms. The general-to-specific technique involves three steps. First, zero to five lags of the first difference of each variable in Equation (8), a constant term (C) and one lagged ECT generated from the Johansen and Juselius technique are applied.[1] Second, the dimensions of the parameter space are reduced to final parsimonious specifications by omitting the insignificant coefficients or imposing statistically insignificant coefficients. The omission of the coefficients also should follow with appropriate statistical and economic characteristics, which typically include appropriate signs and magnitudes of coefficients and/or elasticities. Finally, adequacy of the parsimonious specification will be examined through a battery of diagnostic tests such as serially uncorrelated, normality of residual, heteroskedasticity and mis-specification tests.

Once the equilibrium conditions represented by the cointegrating relations are imposed, the error correction model (ECM) describes how, in each time period, the output is adjusting towards its long-run equilibrium state. Because the variables are supposed to be cointegrated, then in the short term, deviation of output from its long-run equilibrium path will feed back on its future changes in order to force its movement towards the long-run equilibrium state. The cointegrating vectors from which the ECTs are derived are each indicating an independent direction where a stable, meaningful long-run equilibrium state exists. The coefficient of the ECTs, however, represents the proportion by which the long-run disequilibrium in the dependent variables is corrected in each short-term period. Using the model developed in Equation (8), Granger causality tests between the variables can be examined through a joint F-test or a Wald test applied to the coefficients of each explanatory variable in one equation.

Data

Data used in the study are GDP per capita (y), real investment per capita (k) as a measure of physical capital, real education expenditure per capita (h) as a measure of human capital, all of which are expressed in constant Fiji dollars; and the ratio of sum of exports and imports to GDP, which is in percent, representing openness of the economy (p). The analysis covers a 34-year period (1970–2003). The data in annual time series are taken from the "International Financial Statistics" (International Monetary Fund, 2004). All the series are transformed into natural logs because this helps to induce stationarity in the variance-covariance matrix (Chang *et al*., 2001).

Results of Empirical Investigation

Unit Root Tests

The standard ADF (Dickey & Fuller, 1979) test is used to examine the order of integration for each variable at levels and first difference in conjunction with the critical values computed by MacKinnon (1991). For the test for the levels, a trend term is added, while the first differences are tested without a trend. Thus, the variables in levels are tested for trend stationarity and the first difference test investigates the stationarity around a level. Table 2 presents the Dickey–Fuller statistics for the series under investigation. For the level series, the null hypothesis cannot be rejected. However, for first differenced series, the computed ADF statistics are both negative and statistically significant, which leads to rejection of the null hypothesis of unit roots presence, implying that the series are integrated of order one. We, however, recognize that unit root tests can be affected by power and size problems when the true root is less than one as the Dickey–Fuller-bias plague estimation in levels (Enders, 1995) as well as with the presence of structural break (Perron, 1989). As argued by Leybourne *et al*. (1998), p. 192): "... application of Dickey–Fuller tests that ignore the possibility of a break can produce many rejections of the null, *when the break occurs very early in the series*."

In dealing with these problems, we apply the unit root test proposed by Ng and Perron (2001) to re-examine the order of integration for each variable to overcome the power and size problems. Moreover, following Jacques (2003), we split the full sample period (1970–2003) into two sub-periods, namely: pre-period of economic and political instability (1970–1986 and 1988–2003) to examine the possibility of

Table 2. Results of unit root tests

	ADF test		Ng and Perron test, MZa	
Variables in logs	Level (constant with trend)	First difference (constant without trend)	Level (constant with trend)	First difference (constant without trend)
Full sample period: 1970–2003				
y	−1.5739 (0)	−6.7794[a] (0)	−5.2624 (0)	−16.1790[a] (0)
k	−1.7189 (0)	−6.4698[a] (0)	−5.3353 (0)	−11.7872[a] (0)
h	−1.7855 (0)	−4.5643[a] (0)	−2.5723 (0)	−17.0829[a] (0)
p	−2.7672 (0)	−4.7631[a] (0)	−9.3065 (0)	−16.4090[a] (0)
$k \times h$	−1.7507 (0)	−5.2355[a] (0)	−2.9107 (0)	−14.7417[a] (0)
Sub-sample period: 1970–1986				
y	−2.7648 (0)	−5.0336[a] (3)	−4.8026 (0)	−36.2062[a] (3)
k	−0.6880 (0)	−3.0297[b] (0)	−2.3712 (0)	−14.6079[a] (3)
h	−0.2610 (0)	−2.8498[b] (0)	−1.9136 (0)	−7.4376[b] (0)
p	−2.9013 (3)	−3.2926[a] (0)	−14.4327 (3)	−7.7063[b] (0)
Sub-sample period: 1987–2003				
y	−2.9369 (0)	−4.9973[a] (0)	−7.0201 (0)	−6.6248[b] (0)
k	−3.0776 (0)	−5.6616[a] (0)	−6.6823 (0)	−7.0120[b] (0)
h	−3.2327 (1)	−4.0560[a] (0)	−6.9684 (0)	−7.0087[b] (0)
p	−2.6454 (0)	−3.5778[a] (0)	−13.8750 (1)	−7.0723[b] (0)

Note: The ADF critical value at 5% level is −2.9640 and −3.5629 for constant without trend and constant with trend regressions, respectively. These critical values are based on MacKinnon. The optimal lag is selected on the basis of Akaike Information Criterion (AIC). The Ng and Perron critical value is based on Ng and Perron (2001) critical value and the optimal lag is selected based on Spectral GLS-detrended AR based on SIC. The null hypothesis of the test is: a series has a unit root. The figures in brackets denote number of lags. y = log real per capita GDP; k = log real per capita physical capital; h = log real per capita human capital; p = log openness (exports plus imports as ratio of total trade)

[a]The rejection of the null hypothesis at the 5% level of significance.

[b]The rejection of the null hypothesis at the 10% level of significance.

structural break in the series. The results of the tests (both ADF and Ng and Perron) are reported in Table 2. The results of the Ng and Perron test (for all the full and sub-periods) are consistent with the results reported by ADF test. The tests do not reject the null hypothesis if a series is non-stationary in the level, but do reject the hypothesis in the first difference, either at 5% or 10% significance level.

The results of the tests also indicate there is no structural break in the economy; Figure 1 plots the actual values of these series. Results of unit root tests for both periods are consistent. Based on these results, we proceed to test whether these variables are cointegrated using Johansen and Juselius (1990) multivariate cointegration technique.

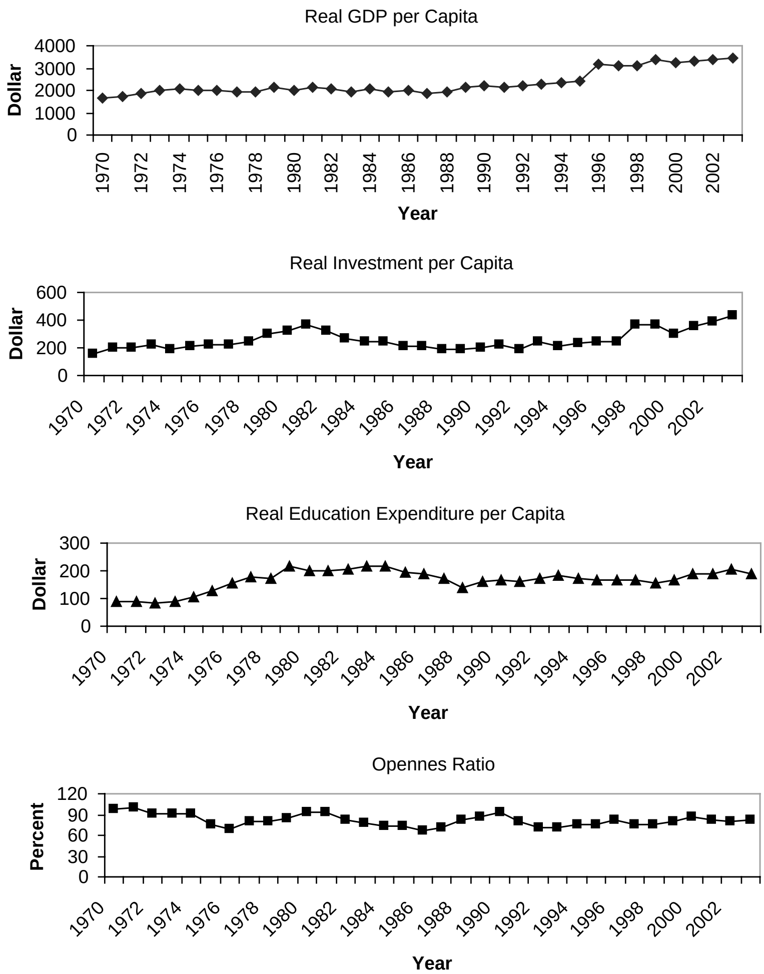


Figure 1. Plots of real GDP per capital, real investment per capita, real education expenditure per capita and openness ratio in Fiji from 1970–2003. *Source:* International Monetary Fund, various issues.

Cointegration Test

Figure 2 reports the results of the Johansen and Juselius multivariate cointegration test statistics, namely maximum eigenvalue and trace statistics. In Panel I of Figure 2, the trace statistic indicates two cointegrating vectors at the 95% level, but maximum eigenvalue statistic shows a unique cointegrating vector in the estimated model. The presence of two or more cointegrating vectors, as in this case, raises the familiar question: Is it better to have many or only a few cointegrating vectors? According to Dickey *et al.* (1991), cointegrating vectors might be seen as representing constraints that an economic system imposes on the behaviour of its variables in the long run. As a result, they claimed that the more cointegrating vectors there are, the more stable is the system. That is, other things constant, it is preferable for an economic system to be stationary in as many directions as possible (Dickey *et al.*, 1991, p. 65).

In contrast, Maddala and Kim (1998) argued that having more than one cointegrating vector raises the problem of interpreting the relationship among

Variables: log *y*, log *k* log *h*, log *p* and DUM
Sample period: 1970–2003 (34 observations)

Panel I. Eigenvalue
0.7273 0.6386 0.4677 0.3633 0.1373

	Maximum eigenvalue		Trace	
Ho:rank = p	Test statistic	95%	Test statistic	95%
$p = 0$	40.28*	38.33	109.96*	88.80
$p = 1$	31.55	32.12	69.67*	63.87
$p = 2$	19.54	25.82	38.12	42.91
$p = 3$	13.99	19.38	18.57	25.87
$p = 4$	4.58	12.52	4.58	12.52

Panel II. Cointegrating estimates (1):

Log *y*	**log *k***	**log *h***	**log *p***	**DUM**	***C***
–1.0000	–2.65**	0.64**	3.99**	–1.03**	7.89
	(4.70)	(2.76)	(4.36)	(–5.61)	

Panel III. Diagnostic checking
VEC residual serial correlation LM tests
H_0: no serial correlation at lag order h

Lags	LM-Stat	Lags	LM-Stat
1	27.92 [0.3115]	3	15.70 [0.9234]
2	22.96 [0.5798]	4	27.47 [0.3327]

VEC residual normality tests
H_0: residuals are multivariate normal
Jacque-Bera normality = 3.76 [0.1525]

VEC residual heteroskedasticity tests: no cross terms (only levels and squares)
H_0: residuals are homoskedasticity
Chi-square = 309.99 [0.3333]

Figure 2. Results of Johansen and Juselius multivariate procedure—without interaction term and with dummy variable (VAR with two lags). *Note:* * and ** indicate significant at 5% and 1% levels, respectively. Figures in square brackets refer to probability values. Figures in parentheses refer to t-test statistics. C = Intercept.

variables. If there is only one cointegration relationship, it may be easy to interpret it as a long-run relationship. However, if there is more than one cointegrating vector, there are problems of interpretation. Consequently, by going in favour of maximum eigenvalue test, we settle for the specification of one cointegrating vector in our analysis. The validity and reliability of the results are examined by using the diagnostic tests such as Breusch–Godfrey serial correlation LM test, ARCH test and Ramsey RESET specification test. The estimated model satisfies the assumptions of classical linear regression model (CLRM) in terms of serially uncorrelated and constant variance, and normality of residuals (Panel III, Figure 2).

Normalizing the equation on log real GDP per capita (Ly) allows us to compare the hypothesized values of the estimated coefficient of each variable in Equation (8), we derive the following cointegration equation from Panel II.[2]

$$Ly = 7.89 - 2.65Lk^{**} + 0.64Lh^{**} + 3.99Lp^{**} - 1.03\text{DUM}^{**} \quad (9)$$
$$\qquad (4.70) \qquad (2.76) \qquad (4.36) \qquad (-5.61)$$

The figures in parentheses denote calculated "t "values and the asterisks denotes the significance at the 5% level.

Except for the coefficient of log of physical capital per capita (k), the signs of estimated coefficients of all variables are as expected. Both logs of real education expenditure per capita (h) and openness ratio (p) are positively correlated with log of per capita real GDP. The dummy variable has the expected sign and has a negative impact have on log of per capita real GDP. Although the estimated coefficient of physical capital is not consistent with a priori, the finding is not entirely surprising. The negative sign relationship between physical capital and real GDP in the Fijian economy does not necessarily contradict theory, as the empirical findings obtained elsewhere reveal that the effects of physical capital on growth are not simple but much more complicated.

From the theoretical point of view as well as from the results of various empirical studies, it has been discerned that the relationship between physical capital and government expenditure is ambiguous, that is, the relationship could either be positive or negative. It is generally realized that not all development expenditures would encourage (private) capital stock accumulation resulting from the constraint of resources either physical or financial, required by both public and private sector investment. Several studies have shown that the consumption expenditures of government such as wages and salaries, and the spending in expanding the government size have negative impact on private investment (Barram & Ward, 1993; Giannaros *et al*., 1999). Indeed, Karras (1996) argued that as the size of government becomes larger, the relationship between public and private investments changes from complementary to substitutability. As a result, the higher cost of capital (above equilibrium rate) leads to the lower rate of private investment (Namzi & Ramirez, 1997), and this phenomenon is referred to as "crowd-out" effect.

If this increase in the cost of capital is large enough and the firm's capital/labour ratio is high enough, more expensive capital could outweigh the benefits of relatively cheaper labour, and thereby decrease output (Forbes, 2002). Obviously, the negative impact of physical capital on growth also depends on the availability of human capital development. It is widely agreed that there exists a complementary relationship between physical and human capital in stimulating output. However, according to the law of diminishing marginal product, if there is a "mis-match" between these two capitals (either more physical capital than human capital, or vice versa), then the relationship might turn from the positive to negative.

Accordingly, we expect a positive relationship to exist between physical and human capital. However, as the reported empirical results are likely to be very sensitive to model specification, we suspect that there are threshold effects in a possible cointegrating relationship between physical and human capital (reported in Figure 2). Indeed, it could be that below a certain level of physical (human) capital there might be a negative effect on human (physical) or a small effect, and a larger effect as physical (human) capital crosses the threshold. In order to take into account the possibility that the relationship between physical and human capital may involve a "threshold effect", we re-estimate Equation (8) by including an additional variable, namely an interaction term ($k \times h$) between log of physical and log of human capital, that is product of k and h.

The results of the equation are reported in Figure 3. The cointegration equation:

$$\underset{}{Ly} = -182.90 + \underset{(8.37)}{81.11Lk^{**}} + \underset{(8.05)}{81.94Lh^{**}} + 2.74Lp^{**} - \underset{(3.92)\,(-8.25)}{35.63Lk^{*}Lh} - \underset{(-0.62)}{0.02\text{DUM}} \qquad (10)$$

The figures in parentheses denote calculated "t" values. The asterisks * and ** denote the significances at the 1% and 5% levels, respectively.

The coefficients of logs of physical capital per capita, human capital per capita, and log of openness have the expected signs and are also significant. On the other hand, the dummy variable though with expected sign is not significant. However, that the sign of the interaction term is negative. It will imply that either of the physical or human capital is not sufficient to complement each other in economic performance. With the negative sign of the interaction term, we can examine the threshold value of human capital above which physical capital starts to have a positive impact on economic growth. The threshold value can be calculated by differentiating the cointegrating estimate (2) (Panel II, Figure 3) with respect to physical and human capital as follows.

By first differentiating the equation with respect to Lk or Lh and set the first derivative equal to zero, we get the threshold value of physical and human capital as follows:

$$\Delta Ly/\Delta Lk = 81.11 - 35.63Lh = 0$$
$$Lh = 81.11/35.63 = 2.276$$

$$\Delta Ly/\Delta Lh = 81.94 - 35.63Lk = 0$$
$$Lk = 81.94/35.63 = 2.300$$

Since all variables enter into the model in logarithmic form and expressed as per capita term, we resort to antilog procedure and obtain the values of physical and human capital per capita. The physical capital will have a positive impact on growth in the Fijian economy when human capital per capita is above \$189 and human capital will have a positive effect on growth when physical capital is above \$200 per

Variables: log *y*, log *k*, log *h*, log *p*, log *k* × log *h* and DUM
Sample period: 1970–2003 (34 observations)

Panel I. Eigenvalue
0.8911 0.7230 0.5243 0.3475 0.2122 0.0060

	Maximum eigenvalue		Trace	
Ho:rank = p	Test statistic	95%	Test statistic	95%
$p = 0$	68.73*	40.07	152.38*	95.75
$p = 1$	39.80	33.87	83.65*	69.81
$p = 2$	23.03	27.58	43.85	47.85
$p = 3$	13.23	21.13	20.82	29.79
$p = 4$	7.39	14.26	7.58	15.49
$p = 5$	0.18	3.84	0.18	3.84

Panel II. Cointegrating estimates (2):

Log *y*	**log *k***	**log *h***	**log *p***	**log *k*×log *h***	**DUM**	***C***
–1.0000	81.11**	81.94**	2.74**	–35.63**	–0.02	-182.90
	(8.37)	(8.05)	(3.92)	(–8.25)	(–0.62)	

Panel III. Diagnostic checking
VEC residual serial correlation LM tests
H_0: no serial correlation at lag order h

Lags	LM-Stat	Lags	LM-Stat
1	26.87 [0.8647]	3	32.54 [0.6339]
2	25.90 [0.8932]	4	33.51 [0.5872]

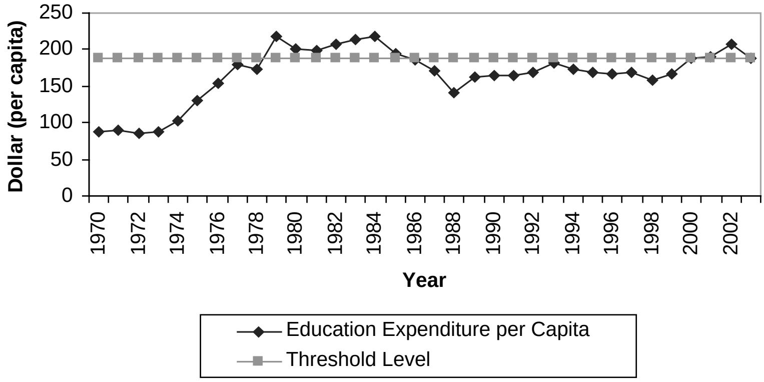
VEC residual normality tests
H_0: residuals are multivariate normal
Jacque-Bera normality = 2.59 [0.2733]

VEC residual heteroskedasticity tests: no cross terms (only levels and squares)
H_0: residuals are homoskedasticity
Chi-square = 510.28 [0.4136]

Figure 3. Results of Johansen and Juselius multivariate procedure—with interaction term and dummy variable (VAR with two lags). *Note:* * and ** indicate significance at 5% and 1% levels, respectively. Figures in square brackets refer to probability values. Figures in parentheses refer to t-test statistics. C = Intercept.

capita.[3,4] The results are clearly demonstrated in Figure 4, which presents a comparison between actual values of physical and human capital with their threshold values, respectively. From Figure 4, we also confirm that there is a threshold between physical and human capital in complementing each other to promote economic growth. It is found that, over the period of 1970–2003, actual value of physical capital is always above its threshold value of $200 per capita, which is able to complement human capital accumulation in promoting economic growth. In contrast, over the same period of study, we found that human capital is always below its threshold value of $189 per capita, which is unable to complement physical capital in stimulating economic growth. This might be the reason why the sign of the physical capital is negative, while the sign of the human capital is positive, with the ultimate result of negative interaction term between physical and human capital.

The above findings have powerful policy implications: Fiji's policy-makers should step up their investment in education so that it leads to a higher rate of economic growth. In absolute value, the size of coefficient of log of human capital per capita



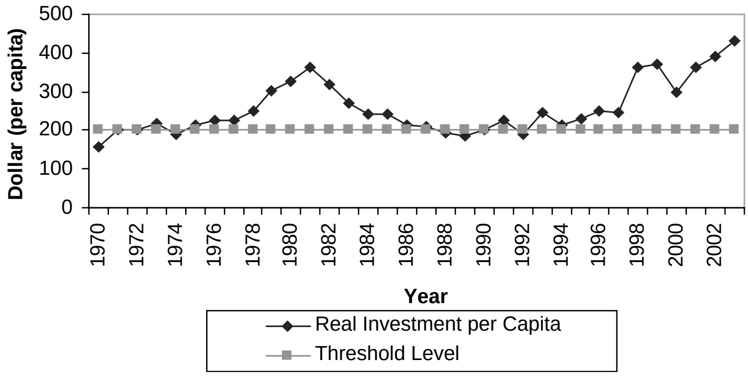


Figure 4. Comparisons between actual values of both physical and human capital and their threshold values. *Source:* The actual values of both physical capital (real investment per capita) and human capital (education expenditure per capita) were collected from the International Monetary Fund, various issues. The threshold values were obtained from the results of the study.

(81.94) is higher than that of log of physical capital per capita (81.11) and log of openness ratio (2.74). Using the diagnostic tests such as VEC residual serial correlation LM test, VEC residual heteroskedasticity test and Ramsey RESET normality test, the reported results emerge to be valid and reliable.

To test the robustness of these results, we re-estimate Equation (8) by including the interaction term between physical and human capital, but omitting the dummy variable (as the variable is insignificant as shown in Figure 3). The results are shown in Figure 5.

The cointegrating equation is as follows:

$$Ly = -147.64 + \underset{(10.57)}{65.47Lk^{**}} + \underset{(10.16)}{66.12Lh^{**}} + \underset{(4.48)}{2.32Lp^{**}} - \underset{(-10.36)}{28.63Lk^{*}Lh} \qquad (11)$$

The figures in parentheses denote calculated "*t*" values. The asterisks * and ** denote the significances at the 1% and 5% levels, respectively.

The sign of all the explanatory variables is consistent with the findings reported in Figure 3. Even though the dummy variable is dropped and there is a minor change in the coefficient value for each variable, the threshold value for physical and human

Variables: log *y*, log *k*, log *h*, log *p* and log *k* × log *h*
Sample period: 1970–2003 (34 observations)

Panel I. Eigenvalue
0.8569 0.4384 0.3596 0.2080 0.0129

	Maximum eigenvalue		Trace	
Ho:rank = p	Test statistic	95%	Test statistic	95%
$p = 0$	60.28*	33.87	99.61*	69.81
$p = 1$	17.88	27.58	39.33	47.85
$p = 2$	13.81	21.13	21.45	29.79
$p = 3$	7.23	14.26	7.63	15.49
$p = 4$	0.40	3.84	0.40	3.84

Panel II. Cointegrating estimates (3):

Log *y*	log *k*	log *h*	log *p*	log *k* × log *h*	*C*
–1.0000	65.47**	66.12**	2.32**	–28.63**	–147.64
	(10.57)	(10.16)	(4.48)	(–10.36)	

Panel III. Diagnostic checking
VEC residual serial correlation LM tests
H_0: no serial correlation at lag order h

Lags	LM-Stat	Lags	LM-Stat
1	25.66 [0.4255]	3	23.93 [0.5233]
2	12.39 [0.9831]	4	25.88 [0.4139]

VEC residual normality tests
H_0: residuals are multivariate normal
Jacque-Bera normality = 2.94 [0.2296]

VEC residual heteroskedasticity tests: no cross terms (only levels and squares)
H_0: residuals are homoskedasticity
Chi-square = 333.05 [0.4425]

Figure 5. Results of Johansen and Juselius multivariate procedure—with interaction term and without dummy variable (VAR with two lags). *Note:* * and ** indicate significant at 5% and 1% levels, respectively. Figures in square brackets refer to probability values. Figures in parentheses refer to t-test statistics. C = Intercept.

capital remains stable. From our calculations based on Equation (11), the physical capital will have a positive impact on growth in the Fijian economy when human capital per capita is above $194 and human capital will have a positive effect on growth when physical capital per capita is above $204. The results would imply that there are no critical economic or political incidents of Fiji that can lead to the major change or structural break in changing the stock of both physical and human capital, and thereby by impacting economic growth. For example, within 1970–2003, Fiji faced a military coup in 1987 and a civil disorder in 2000, but these incidents did not bring about major change in GDP.

Error Correction Model

Having established the existence of a long run equilibrium relationship among these variables, we proceed to estimate the Equation (8) by the general to specific method, capturing the short-run dynamic adjustment of cointegration variables. In other words, the transitory components of the series can be given a dynamic error correction representation, that is, a constrained error correction model can be applied in examining the causality relationship between dependent and explanatory variables. As the first step in estimating the equation, zero to four lags of the first difference of each variable in Equation (8), a constant term (C) and one lagged error correction term (ECT_{t-1}) generated from the Johansen and Juselius technique are added. After that, as required by the general-to-specific method, the dimensions of the parameter space were reduced to final parsimonious specifications by eliminating insignificant coefficients or imposing statistically insignificant coefficients (Hendry, 1987). Under this approach, the adequacy of the developed models must come first by using some diagnostic tests until after a statistically adequate model has been found (Brooks, 2002).

Table 3 presents the parsimonious vector error correction model (PVECM) results. Diagnostic tests such as Breusch–Godfrey serial correlation LM test, ARCH test, Jarque-Bera normality test and Ramsey RESET specification test have been used to

Table 3. Error correction test results

Variable	Coefficient	t-Statistic
$D(\log y(-3))$	−0.6420	−3.2315[a]
$D(\log k)$	15.4632	3.6635[b]
$D(\log k\ (-1))$	17.5871	3.4798[a]
$D(\log k(-2))$	−8.7139	−2.7077[a]
$D(\log h)$	16.2359	3.7432[b]
$D(\log h(-1))$	17.1638	3.3907[a]
$D(\log h(-2))$	−7.7109	−2.5073[a]
$D(\log h(-3))$	0.7147	2.8816[a]
$D(\log p)$	0.6655	3.4732[a]
$D(\log p(-1))$	0.4228	2.7510[a]
$D(\log p(-3))$	0.6226	3.3007[a]
$D(\log p(-4))$	−0.1852	−1.5934
$D(\log p(-5))$	0.1902	1.3787
$D(\log k \times \log h)$	−6.9455	−3.6772[b]
$D(\log k \times \log h(-1))$	−7.7963	−3.4814[a]
$D(\log k \times \log h(-2))$	3.6363	2.6313[a]
$D(\log k \times \log h(-3))$	0.0412	0.8991
$D(\log k \times \log h(-5))$	0.0842	2.3493[c]
DUM	0.0710	5.0710[b]
C	−0.0319	−3.4208[a]
R^2	0.9251	
Adjusted R^2	0.7111	
Diagnostic checking		
Jarque-Bera	$\chi(2) = 1.2130$ [0.5452]	
Breusch − Godfrey Serial correlation LM test	$F(1) = 0.1421$ [0.7191]	
ARCH test	$F(2) = 1.9322$ [0.1767]	
Ramsey RESET test	$F(1) = 2.4299$ [0.1701]	

Note: Figures in square brackets refer to marginal significance levels. Figures in parentheses refer to the lag length used in testing the battery test. The dependent variable is log y.
[a]Significant at 5% significance levels.
[b]Significant at 1% significance levels.
[c]Significant at 10% significance levels.

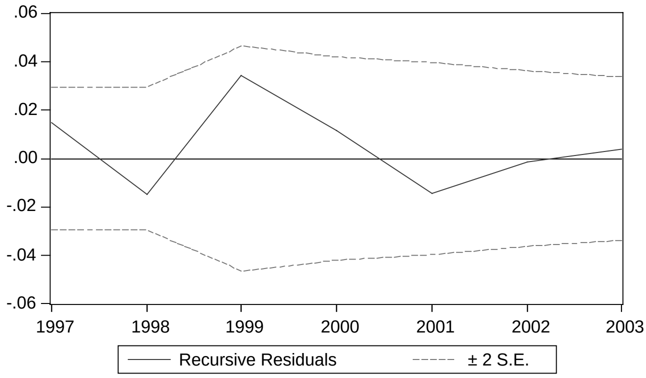


Figure 6. Recursive residual plot for short-run model.

examine the reliability of the estimated model. Diagnostic statistics for serially uncorrelated and constant variance, and correct functional form assumptions are satisfactory. Moreover, the CUSUM and CUSUM of squares plots (Figures 6 and 7) show that the parameters estimated are stable over time as well as the goodness-of-fit of the model remains convincing as the adjusted R^2 (0.7111) is quite high.

The one lagged error correction term (ECT_{t-1}) is significant and has the proper negative sign for log of real GDP per capita equation. Significance of the ECT for the equation implies that causality runs from all explanatory variables to log of real GDP per capita in the long run. The size of the coefficient of the lagged ECT for real GDP is –0.65170 indicates that 65.17% of the adjustment of real GDP towards the long-run equilibrium takes place per year; this is a relatively high rate of adjustment. According to the dynamics of the log of per capita real GDP equation, changes in log of real investment per capita (as a measure of physical capital), changes in the log of real education expenditure per capita (as a measure of human capital), log of openness ratio and the interaction term between physical and human capital have significant short-run effects on log of real GDP per capita, in addition to the long-run effects (Table 3).

In the short-run, the impact of physical capital, human capital and openness ratio are positive and statistically significant, while the interaction term between physical

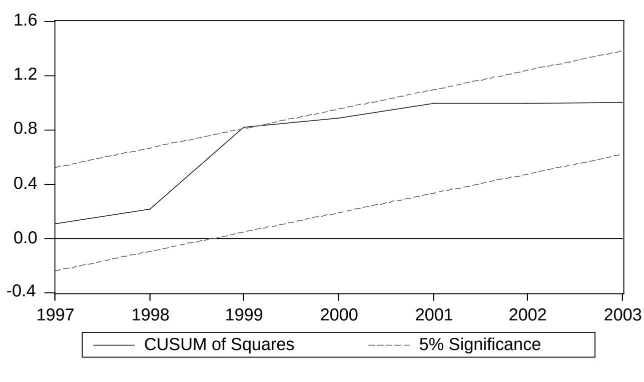


Figure 7. CUSUM of squares plot for short-run model.

and human capital is negative and significant at 5% significance level. On average, the log of human capital per capita imposes a higher effect (26.4035) than the log of physical capital per capita (24.3364) and log of openness ratio (1.7109). In sum, we provide some evidence of the effect of some endogenous variables on the Fijian economy.

Conclusion and Policy Implications

In this paper, we applied Johansen and Juselius multivariate cointegration procedures and Hendry's general-to-specific approach within error correction model to examine the determinants of growth in Fiji, which has been following open trade policies. The results reported in the study demonstrate that the long-run economic growth of Fiji can be represented via a cointegrating regression framework including real education expenditure per capita, real investment per capita and openness ratio. The short- and long-run elasticity coefficients of these variables conform to expectations. It is found that not only both physical and human capital are crucial in promoting Fiji's economic growth, but also is the openness policy of Fiji a major determinant of the growth in the short- and long-run. The findings suggest that endogenous model can explain development in the Fijian economy over the past three decades quite successfully.

A major factor in the endogenous growth over the short- and long-term is human capital development, as compared to physical capital and openness policy. This variable is very strongly influenced, which has exhibited steady trends on the economic performance. Development of human capital needs further strengthening through increased access to education, improvements in labour productivity and raising skilled labour force so that human capital would complement physical capital to promote high rate of growth in the Fijian economy. In the context of current steady level of migration of skilled labour to greener pastures, it will be a real challenge for policy-makers.

Notes

[1] In case of the dependent variable, one to five lags are applied in the right-hand side of the equation.

[2] The normalized equation is obtained by dividing each cointegrating vector by the negative of the cointegrating vector on log of real GDP.

[3] These values are obtained through the following antilog procedure: antilog (2.276) $= 10^{2.276} = 189$ and antilog (2.300) $= 10^{2.300} = 200$.

[4] See Engle and Granger (1987) for a detailed discussion of the error correction modelling techniques.

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